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Proposal No. 552

VERSATILE, HIGH PRECISION
STEREOSCOPIC POINT TRANSFER DEVICE

Prepared By

[redacted]

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[redacted]

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March 1963

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SECTION 1

INTRODUCTION

This proposal describes the modifications proposed by [redacted] to its Model 387 Stereo Viewer in order to fulfill the requirements for versatile, high precision stereoscopic point transfer device. STAT

The above-referenced high magnification stereoscopic viewer was originally developed by [redacted] under Contract [redacted] The general description for this viewer is presented at the end of this proposal. In addition, many of the features and techniques described herein have been incorporated into several operational devices produced by [redacted] A partial listing is as follows:

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<u>Model 373 Viewer</u>: This is a stereoscopic viewer for measurement and viewing of dual formats: up to 9½" x 40" each, with magnification of ½x to 30x. Employs Moire fringe readout. Developed and delivered to the [redacted] This system contains an optical switch to reverse eye-station relationship (similar to that proposed here).

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<u>Model 344A Viewer</u>: Similar to the above except that it employs Coleman digitizers for automatic measurement. Developed and delivered to the [redacted]

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[redacted]

Joy Stick Control and Scan Drives, [redacted] Model 480: This standard joy stick control system is now in use in Model 387 Viewer and Model 527A X-Y Motion Comparator. The latter is an X-Y comparator developed for the [redacted] More than 5 of these systems have been produced in which a high degree of reliability has been recorded.

General Description:

The proposed viewer shown in Figure 1 allows stereoscopic viewing of roll or cut film transparencies of varying format sizes up to 10" x 20". The observed magnification is continuously variable (in three steps) from 4.2x to 135x. The zoom control of the right and left formats can be independently or simultaneously varied by a motorized drive actuated from the control panel. Scanning is provided for left and right format either independently for overlap control or simultaneously for stereo scan. Variable speed X-axis and Y-axis drives allow continuous control of speed from .0005"/sec. to 1.0"/sec., actuated by a joy stick on the control panel; in addition, stepping action allows the operator to position the objective optics to better than one micron.

A film takeup loop between the right and left formats is provided that can be controlled from either left format, right format, or kept constant. In addition, two independent film rolls (up to 500' each) can be placed in the viewer so that a frame in one roll can be stereo scanned with another on the second roll.

[redacted]

The viewed images are transmitted through 3/4" square fiber optics flexible cables fitted with [redacted] Image Enhancers, for increased clarity and resolution. The fiber optics ends can be rotated by ±180° to allow independent angular orientation of the right or left formats. The eyepiece end contains provisions for adjustment for maximum operator comfort including interpupillary, up-down, and in-out adjustments.

Two optical switches are provided within the eyepiece assembly: the first allows the selection of right frame with right eye, left frame with left eye; or, right frame with left eye and left frame with right eye. The second optical switch allows the introduction of a dove prism within the parallel path of the eyepiece so that either or both viewed areas can be reversed. Compensation at the joy stick for the reversal of the image is achieved by an electrical switch, in order to assure correspondence of joy stick motion to the viewed image. The joy stick is located within a rotatable mount so that it can be adjusted to correspond to the orientation of the fiber cable.

A projected reticle is provided that can be varied in diameter to be observed as 1' to 4' of arc at any magnification. Film identification is achieved by two lasers: one on the left and the other on the right frame, with an interchangeable reticle allowing variation of the identification configuration. The optical system assures that the location of the projected reticle relative to the identification mark, is located within an accuracy of ±1 micron. This is achieved by having no moving parts required to produce the identification mark.

Numerical identification is supplied with a capacity of 00 to 99. Selection of the number is achieved by a solenoid actuated counter located at the control panel that is automatically advanced when the laser pulse is actuated. The counter in turn automatically advances the numbers on discs at the objective by two Ledex stepping drives at each objective.

A point mark position indexing system is provided to display the X and Y axes of each scan area. These 4 counters are located at the eyepiece assembly, so that the operator lifts his eyes only slightly to observe the 4 counters. These counters (000-999) are reversible and resettable.

In order to assure that the system is least sensitive to vibration, it is supplied on 4 vibration isolators. The selection of the isolators is based on the vibration frequency and amplitudes expected at the operational site. The structure supporting the carriages is rigidized to assure the capability of at least 600 lines/mm at the film plane. The system used is Model "387" viewer, which has shown the capability of at least 400 lines/mm (at 50x magnification). Further magnification to 125x, and the additional rigidity assures that a minimum of 600 lines/mm can be achieved.

[redacted]

SECTION 2

OPTICAL SYSTEM DESCRIPTION

Figures 2 and 3 are the optical schematics for the High Magnification Viewer. The optical system has three overlapping ranges of object magnification infinitely variable between their limits: 4.2x to 18x with 1x objective lens and 10.5x to 45x with 2.5x objective lens, and 31.5x to 135x with 7.5x objective lens. This is achieved by using a fixed 6x eyepiece. A zoom lens system provides the infinitely variable magnification (0.7x to 3x). The objective lenses are extremely high resolution microscope objectives made by [redacted] STAT The resolving power of the 7.5x objective exceeds 1,000 lines/mm due to its numerical aperture, and its design being close to diffraction limited optics. The image information from the objective assembly is relayed to the eyepiece assembly by use of fiber optics cable. A flexible coherent bundle contains glass fibers .0004" diameter that permit image rotation and positioning of the eyepieces over a wide range without a complex conventional optical system.

High Intensity Light Source (Figure 7):-

A high intensity light supplies variable illumination for the viewing optics. It is located on an arm attached to the vertical support of the objective assembly, and, therefore, tracks the viewed area on the film. A G.E. #1594 lamp is used. In order to assure that the numerical aperture of the objectives are filled with light, the lower surface of the glass plate is a diffusing ground glass surface.

To prevent overheating dense portions on film, the high intensity light source is fitted with one (1) heat reflecting filter immediately in front of the lamp and two (2) heat absorbing filters at the condenser's output. The filters as well as the condenser lenses are in a cylindrical assembly that may be moved axially for adjustment of spot size at the ground glass surface of the support plate. The lamp is easily removed through the access opening in the cabinet sides after the fluorescent lamp assemblies are removed. The socket used for the lamp is an improved prefocused version that assures high reliability of contact after extensive usage.

Either one of the objective lenses, 1x, 2.5x, or 7.5x, may be selected by a switch on the control panel; the chosen lens is then electrically driven into place on the optical axis. The three lenses are located on a turret similar to that used on [redacted] Models 344A and 373 Viewers. The objective lens provides an image of fixed mangification that is relayed to the fiber cable by a variable focal length lens system. The zoom magnifier offers infinitely variable magnification between .7x and 3x in addition to the objective lens. The zoom magnifier is manually or electrically driven, being controlled by a switch at the control panel or a knob on the objective assembly. A dial indicates magnification of the zoom lens system. Separate electrical controls are provided for the right and left formats. In addition, another switch enables simultaneous variation of both formats.

A field lens at the image plane formed by the objective lens assures full objective lens field coverage by the zoom magnifier and a uniform bright field making full use of the objective lens aperture.

Each objective lens is mounted in a threaded sleeve so that precise focusing can be made especially for the 2.5x and 7.5x lenses where maximum resolving power is required for the high magnification range.

Since the eyepiece power is fixed at 6x, system magnification will be the product of objective lens, zoom magnifier and eyepiece magnification. A separate section of this proposal describes the optical switches at the eyepiece assembly.

The image enhancer scanning optics are located at either end of the fiber cable and scans image points over many fibers. Because there may be imperfections in the fiber structure, such as broken fibers, the image scanning technique integrates the image brightness as seen through the transmitting and opaque areas of the cable in the scan circle. The image enhancing motor and mechanisms are shock mounted in order to minimize possible vibrations. In addition, sound-proofing techniques will be used to eliminate the noise being transmitted to the operator. All covers and inner structure of the supports of the image enhancers will be covered with sound-proofing foam to dampen audible noise.

To assure that input and output scanning motions track each other for maximum image information, a phasing operation is required. Here, phase shifting is effected between corresponding enhancer motors electrically for small fine positioning (approximately 5°), and mechanically by stator rotation for larger phasing adjustment. A constant voltage A.C. power supply is

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provided in order to assure that the phase setting is fixed independent of large variation of the input voltage to the viewer optical switches.

The eyepiece assembly supports the fiber cable ends, the eyepieces and the enhancer motors. The assembly is in two halves corresponding to right and left channels and are hinged to provide the interocular distance adjustment. The eyepieces are mounted in a threaded sleeve permitting independent focus adjustment to suit the operator's vision. A headrest is provided having a small adjustment range for viewing comfort. The entire eyepiece assembly can be positioned through a range of vertical, front-to-back and angular positions to suit many operator statures and viewing positions. The motion of the eyepiece assembly is identical to that provided in Model 387 Viewer: ±3" up or down, ±3" back and forth, and 0 to 30° angular displacement. Interpupillary distance is adjustable 2-1/4" to 3". Exit pupil is 9mm.

General Illumination:-

General illumination is achieved by a bank of fluorescent fixtures (as shown in Figure 8). This type of light fixture is interchangeable with cold light sources already provided to [redacted] for X-Y Motion Comparators [redacted] The latter type is a cold cathode which is variable in illumination from 50 to 1,000 foot-lamberts. The cost of the fluorescent type fixtures to that of the cold cathode system is approximately the same. Consequently, the cognizant government agency can select either of the alternates.

[redacted]

Eyepiece Assembly:-

The eyepiece assembly includes all the optical switches required for the system. It contains relay lenses which collimate the images from the fiber cables. Parallel light is then provided at the optical switches, so that no focusing is required, as the optical switches are actuated. This system is very similar to the optical switches developed by [redacted] for Model 373 Viewer, except that it is folded to result in a small compact package. STAT

Figure 3 illustrates the optical schematic. As shown, the right fiber cable's exit image is first passed through the image enhancer, onto the mirror M1 which directs it upward. L1 is a collimating lens of 7" focal length of high resolution, being the same as that used for Model 373 Viewer. The collimated beam is then passed through the first optical switch which contains a dove prism. This prism bends the light onto the long surface of the prism, which causes it to encounter a single reflection. Consequently, it acts like a single mirror, with the exit beam being in line with the entrance beam. This prism may be placed in order to reverse right to left orientation on film (negative to positive or vice versa). It can be inserted into the path or removed from the path by a knob located externally at the eyepiece assembly. A similar prism is located at the left cable to achieve independent reversal of right or left channels.

The exit illumination from the dove prism is directed to M2, to M3, and down to the lens L2; L2 is selected to be identical to L1 so that a 1:1 image is formed at the focal plane of the 6x eyepiece. In this manner, maximum resolution and minimum distortion is achieved. L2 forms the image of the fiber cable behind the eyepiece after reflecting at M4.

The left fiber cable imaging system is identical to the right. The lower portion of Figure 3 illustrates stereo viewing where the right eye observes the right image and the left eye observes the left image. An optical switch is provided by rotating the mirrors M2, M3, M5 and M6 as shown in the upper figure of Figure 3. In this manner, the right fiber optics image is transmitted through M2 onto M6 and onto the left eyepiece. The left fiber cable image is transmitted through M5 to M3 and then onto the right eyepiece.

Fiber Optics Cable:-

In order to achieve a large field of view at the eye a 3/4" x 3/4" flexible fiber optics cable will be used having 10 micron fibers. The resolution obtained by utilizing the image enhancer is better than 60 lines/mm at the fiber cable. A 6x eyepiece will be used so that the resultant field of view is twice in diameter to the 387 Viewer which utilized a ½" cable and 4.45x eyepiece.

Reticle Dot:-

The reticle system is shown in Figure 2. It is located at the objective assembly between the objective lens and the zoom optics. A small filament source and condensing optics constitute the illumination of the projected dot.

The dot is formed as the illumination exiting from an iris diaphragm through a relay minification lens. The iris diaphragm contains over 10 blades, so that a circle is formed within the opening of the blades. The advantages of utilizing an iris are many, among which is the variation of diameter by 30 to 1, the maintenance of focus independent of size, and that the center of the iris is maintained fixed independent of its aperture. Manual control of the iris is provided by an external knob. An optional feature is described separately whereby the size of the iris is automatically varied to compensate for zoom magnification.

The subtended angle of the reticle to the eye is from 4' to 1' minimum at all magnifications. Continuously variable illumination of the dot is provided at the control panel.

Point Marking and Point Flagging System:

Appendix I describes the tests and results obtained by for point marking and flagging system using lasers. Analysis and conclusions are presented, design parameters were determined, as detailed in Appendix I.

Based on the above, the proposed optical design for point marking is shown in Figure 2, which includes all the design requirements of Appendix I.

Two light masers are used; one on each objective: the pulse power is approximately 1½ joules with a threshold energy of 0.3 joules. The power supplies will be mounted on a standard 19" rack; which also includes the controls for the viewer. The height of the rack is approximately 30". Control of the output energy of the power supplies is provided to allow initial optimization by the operator. The suppliers for the lasers is E.G. and G. or T.R.G., or equivalent. The laser head itself is small, 6" diameter x 8" long, which can be located at the outer edges of the objective head.

The exit pulse from the laser is directed by light gathering lenses onto the marking apertures. The purpose of these lenses is to assure uniform distribution of energy onto the reticles independent of the distribution of illumination from the ruby rod. The image of the reticles are displayed onto the film planes after passing through a relay lens which images the illumination at the field lens which is then focused by the objective lens onto the film.

The design of the optical system provides for a large size reticles in order to distribute the laser energy over a large area so that the reticles are not overheated. In addition, the illumination is distributed to fill the aperture of the lenses in order not to concentrate the heat over a small area. Consequently, high reliability may be achieved. Since a large size reticle (magnified 20x from the film plane is used), the edge gradients may be limited to 1 micron.

In order to provide a quick means for looking at the image of the marking reticle on the film prior to actuating the laser, two small filament lamps illuminate a diffusing disc surrounding the laser rod. This illumination is then passed through the marking reticles, which can then be observed at the film plane. In this manner, the operator merely actuates the auxiliary switch at will in order to observe the identification mark.

The point marking reticle is contained within a fixed reticle holder. The shape and size will be determined after a preliminary study. A possible selection may be a reticle of donut shape of outer diameter 40 microns, and inner diameter of 25 microns.

The point flagging reticle may be also a donut shape surrounding the point of .060" inner diameter and .070" outer diameter. This aperture may be included on the same point marking reticle shown above. Within this dual reticle two spaces are provided so that the image of two numbers can be passed through. The numbers are located on metal evaporated glass discs one on each side of the reticle. The evaporated surfaces are located next to the reticle to minimize the amount of defocus. However, optimum focus is achieved at the reticle plane. The slight defocus caused at the numbers only increases the line width of the numbers very slightly, without effecting its legibility. The location of the numbers is proposed within the circle, so that each number may be .050" high. However, size as well as various types of arrangements will be investigated. Optimum shapes will be evaluated to determine easiest means of location. In addition, recording the numbers in digital form as dots will also be studied. In any event, the arrangement described above gives a high degree of flexibility since the discs and reticle can be interchanged.

Each number disc contains 12 positions: 10 numbers, a blank area and open area. Selection of any position is achieved by a switch at the control panel which automatically indexes a stepping Ledex system so that the position of the disc corresponds to that of the control switch.

An interlocking system with fail-safe features is provided so that when the laser pulse is actuated, a solenoid is first actuated to shutter any of the illumination to reach the eye of the operator. If these solenoids are not actuated, the laser cannot be energized.

Alignment of illuminated dot reticle to identification reticle. The design of the optical system (Figure 2) assures that alignment (once it is set) is maintained after extended usage. It may be noted that the same beam splitter directs the illumination from the projected dot onto the eyepiece, and directs the laser beam to the film plane. Any misalignment of the beam splitter effects both reticles in the same manner. The objective lens system is mounted on a turret, with precision stops, so that when the high magnification objective lens is in operation, the turret stops at an exact position.

It must be noted here that the proposed arrangement provides the actuation of the laser only when the high magnification lens is in the field of view (the range of magnification here is approximately 30 to 130x.). The operator must push the high magnification selector button first, then scans with the joy stick until the reticle dot is on the point of interest. The repeatability of the high magnification lens in positioning will be designed to achieve 1 micron repeatability at the film plane. In addition to the above,provisions are made so that the dot may be aligned to the marking reticle by energizing the separate illumination of the marking system. The operator may then observe if there is any discrepancy in alignment. Two thumb controls are provided at the iris (simulating the dot) so that it can be adjusted in the X and Y axes, so that both reticles are in perfect correspondence. The location of these adjustments are made conveniently in front of the objective lens assembly in order to allow the operator to view the eyepiece and adjust the reticles at the same time. The above alignment should only be made infrequently. It is definitely not effected by the zoom mechanisms, since the zoom optics do not effect the relationship of the two reticles.

If the design of the optical system is such that when the operator aligns the reticle to the point of interest on the film, he can check his alignment of the marks if he desires. He then pushes the "Laser pulse" button. The action of the laser is completely electronic. No mirrors or optics have to be displaced. Consequently, there is no possibility of jarring the objective to get it out of alignment.

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Film Hold-down System:

In order to achieve maximum resolution and flatness, vacuum hold-down is used. The lower plate contains ½" thick glass which is polished to better than one wavelength of green light. The upper plate contains a groove system sub-contracted to [redacted] Adjustment screws are provided around this plate so that the space between the objective and glass is maintained fixed to better than .0004". In order to select the utilization of 35mm, 70mm, 5" and 9½" film a hinged cover is adjusted to cover the area that is not used so that vacuum can be assured. A vacuum pump is provided, manufactured by [redacted] Solenoid valves are supplied to automatically remove vacuum prior to film advance. Separate vacuum control is achieved on the two separate plates each covering more than 10" x 20" area.

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Point Mark Position Indexing System:

Four (4) reversible counters are provided near the eyepiece assembly to define X and Y axis of the carriages in the right and left frames. Each count represents 1mm. The counters are resettable to zero. The sensor is geared to the ball screw drives. Each counter has three numbers. A cable will be provided so that the location of the counters may be remotely located at the discretion of the operator.

SECTION 3

MECHANICAL DESCRIPTION

Scan Drives.

To position the objective lenses over the format area a scanning drive with X and Y carriages are independently positioned by an infinitely variable two-range electric motor powered drives. A joy stick at the control panel provides two axis scan direction and velocity control is fitted with necessary switches for speed range selection and channel activation. With this arrangement one-hand control is possible for rapid and precise positioning of the carriages. Figure 10 is a photograph of the scan drive mechanism (Model 387 Viewer); Figure 11 is the schematic of the scan drive showing the relationship of the components used.

Each axis prime mover is a specially made direct current motor powered by a thyratron controlled power supply located at the base of the cabinet. As the joy stick is advanced from neutral position, the motor speed increases proportionally over a range of 50:1. To further increase speed, the high speed selector can be engaged. Here a magnetic clutch disengages 6.3:1 speed ratio and another clutch engages 1:6.3 ratio in its place at the motor's output shaft. Therefore, a 40 times increase in scan speed is arranged; high range - .02"/sec. to 1"/sec.; low range - .0005"/sec. to .025"/sec. In addition to the above, a slow mode is provided with fixed speeds of approximately 3 microns per second. In this mode a repetitious pulse is provided allowing the

[redacted]

drive to advance in steps, allowing close positioning to better than one micron. This pulsing action has been found to allow very good control on X-Y motion comparators developed for the TIIF Program. The selection of high, medium, and low speed is achieved by making the joy stick consist of an external shell that can rotate around an inner tube. The outer shell can be rotated by the operator to position it in one of three detented positions. Extreme clockwise: slew; Center: medium speed; and extreme counterclockwise: very slow. In this manner described above the operator rotates the joy stick handle to select his speeds, and pushes the handle right, left, up and down to achieve the desired scanning direction.

The joy stick mechanisms are located within a rotatable mount that can be oriented continuously to ±180° by a self-locking tangent screw drive. Dials are provided at the joy stick to indicate orientation. In addition, the orientation of the fiber optics cable (image orientation) is also indicated by an associated dial; in this manner, the operator may set the orientation of the joy stick assembly to correspond to the image rotation, so that moving the joy stick up moves the image up (as observed at the eyepiece). In addition to the above, a reversing switch is located at the control panel to allow correspondence to the negative-to-positive optical switch. The purpose of this switch is to reverse the direction of the X-axis motor. This motor would then effect a mechanical direction reversal in correspondence with the optical reversal allowing correspondence of joy stick motion to optical orientation at any position of the optical switch.

Either left, right, or both channels can be operated at the joy stick by a switch mounted at the control panel. This control electrically disconnects the channel that is desired to be fixed, or allows both channels to be moved in unison for stereo viewing with a constant center distance between objective lenses. By disconnecting either channel overlap can be quickly altered. It can then be fixed by centralizing channel selector switch, at which the joy stick will move both channels simultaneously.

Ball screws position the X and Y carriages with little backlash and resistance. Since all wearing surfaces are hardened, little loss in the screw's precision with use is expected. Backlash is controlled by two ball nuts mounted back-to-back in a threaded mount so that minimum backlash can be easily obtained by relative motion between nuts and thread. Axial motion of screw is restrained by a preloaded pair of ball bearings at the magnetic clutch coupling. The screw's outboard end is radially supported by a ball bearing that can float axially accepting changes in screw length without restraint.

The Y axis uses a ball spline to transmit motion to either screw at any point in the X axis travel. The ball bearing construction gives low friction, little wear and backlash and is especially useful for very small displacements or low velocity scanning where effects of friction are more pronounced. The spline's sliding member is fitted with a timing belt pulley that in turn drives a precision bevel gear right angle drive of the screw. The combination yields a low backlash drive with good sensitivity to direction reversal.

The carriage guides for both axes are rods and ball bushings made with hardened and ground surfaces. Alignment and axis relationship are maintained by dowel pinned supports on the frame and carriages. Mid-span of rods is supported to improve its rigidity under load.

The support frame is a heavy walled steel weldment thoroughly stress relieved and precision ground on the mounting surfaces. Supports at each corner mount the frame mass directly on the floor with leveling jacks. Adjustment of 3" ±1", as measured from cabinet's bottom surface to floor, is provided by the jack screws. A lock nut on each screw will secure the leveling adjustment. In addition, vibration isolators are provided as shown in Figure 1.

An optional feature described later in this proposal details an alternate casting design to replace the weldment in order to provide rigidity adequate for future utilization of the machine for precise measurement.

Light Box.

The means for holding and transporting the film and providing general illumination is arranged in the light box assembly. This mechanism is rigidly supported by the frame so that the film is held steady during viewing.

To guide negative or positive film into and out of viewing area, there are two pairs of polished free-turning rollers installed between the pressure plates and spools. The upper roller is hinged at the rear so that film loading between rollers is simplified.

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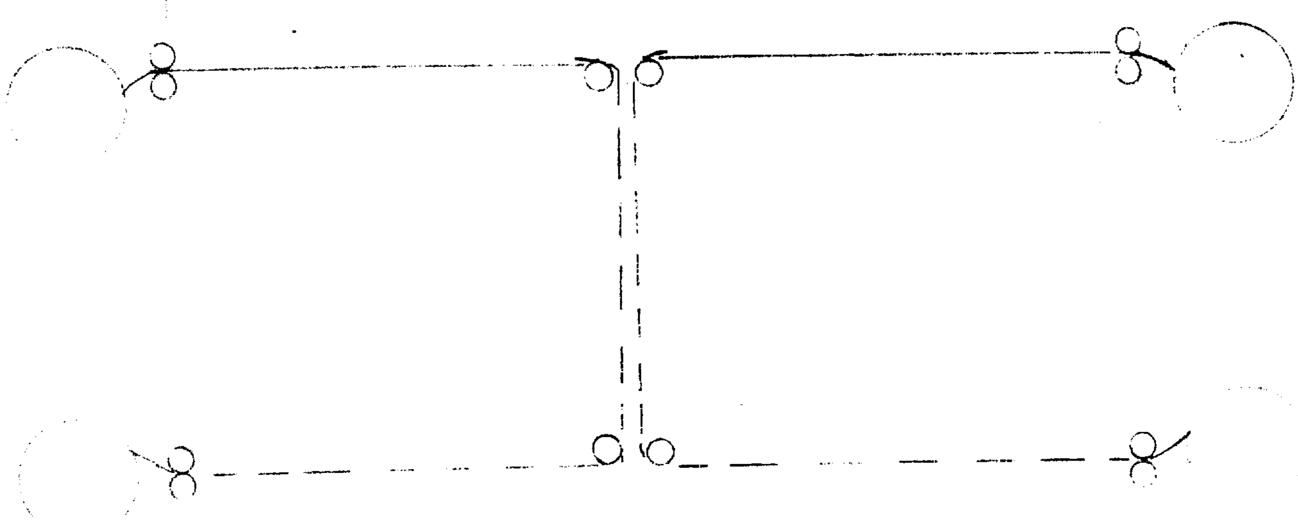
Four (4) film spools are provided: two on the right, one above the other, to handle the drive of one film for widths of 35mm up to 9½", and two on the left for a second similar roll. The capacity of the spools at either side is up to 500 feet.

To load two rolls, one on the right, the other on the left: insert the film spools on the top right and left. Then, extend the film from the right film roll between the guide rollers to the center of the viewer and attach it on a clip at the center roller. Next, extend the end of the left film roll onto the central roller and attach it to a second clip on the central roller, as shown below:



Next, push the loop forming switch. The rollers would automatically go down onto the path shown dotted above until rollers stop next to the sides of the viewer. The operator then merely holds the ends of each film and attaches it to the correspondent empty spools.

The above automatic threading system is simply accomplished by using the loop forming mechanisms already provided within the viewer. It has the advantage of simplicity, requiring no additional mechanisms. The film loading procedure may be accomplished either by automatically threading both film rolls at the same time or loading the right film first, then returning the loop forming rollers up by the motorized drive, after which the left roll may be loaded.

To load one film roll to view adjacent frames, simply place the supply and takeup at the upper right and upper left spool holders, laying the film flat across both right and left viewing areas. In this mode, the loop forming mechanism can be used to form a loop up to 14 feet as described in a separate section of this proposal.

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Loop Forming Mechanism (Identical to Model 387 Viewer). (Figure 9.)

As a part of the film handling facility in this instrument a film loop can be formed between the adjacent viewing areas containing as much as 14 feet of film (center of right format to center of left format). Controls for the loop forming mechanism are located on the control panel and consist of a mode selector switch and a pushbutton. The modes of operation are essentially loop forming, holding a fixed loop length and loop withdrawal. Except for loop withdrawal, all functions are electrically driven or actuated. Manual withdrawal of loop is performed by rewinding film onto either of the spools with the choice up to the operator. The mode selector switch will direct the mechanism from which channel the film is to be withdrawn for the loop. Once the channel is selected, a choice to use the "Manual Withdraw" or "Lock" modes can be made. A loop may be formed in either position; the purpose of the choice will be whether the operator wishes to form and withdraw the loop or to form and hold the loop, respectively. The mode selector may be moved after the loop has been formed to any position, if the operator decides to change withdrawal from the other channel or wishes to disband or change length of loop held in storage.

The loop forming mechanism consists of a pair of rollers attached to parallel chain circuits that are coupled by interconnected sprockets. When not forming a loop the rollers are above the film plane between the viewing areas as seen in Figure 4 . In operation, after the pressure plate is raised, the lower roller of the pair makes contact with the film drawing it between two fixed free-turning rollers that form a slot and protect the film during the loop forming operation. As the moving rollers travel downward the loop length increases. At the "knee" of the chain circuit the pair of moving rollers separate and begin to travel in opposite directions enlarging the loop into an inverted "T" as in Figure 9 . The limit is reached when moving rollers reach the end sprockets where the loop forming drive motor is shut off by a limit switch. Free-turning fixed rollers support and protect the film as it turns from vertical to horizontal paths at the "T" (idler roller in Figure 9) and midway under the long span between the limit sprockets.

To retract or withdraw the film loop, rotate the film winding handle of the selected channel as to be turned to wind film on the spool. The opposite spool will be braked by a magnetic brake on the opposite film drive. Tension in the film will return the forming rollers on the path they took in forming the loop. If desired, the withdrawal process may be stopped at any point in order to return to viewing of the film strip.

An electrical interlock between the vacuum and film transport or loop forming operation is made so that a solenoid actuated valve removes the vacuum during manual film drive or loop forming mode.

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TOLERANCE UNLESS OTHERWISE SPECIFIED — TOLERANCES ARE NOT INCLUDED
DEC DIMS ± FRAC DIMS ± ANGULAR DIMS ±

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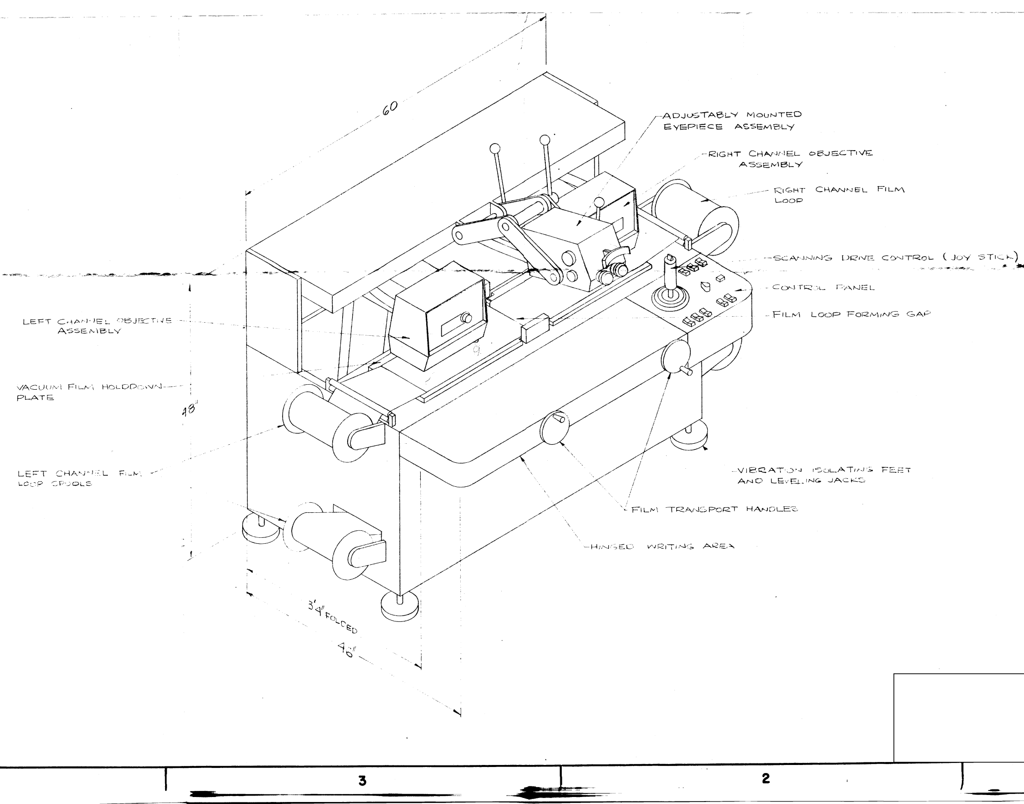

FIGURE 1

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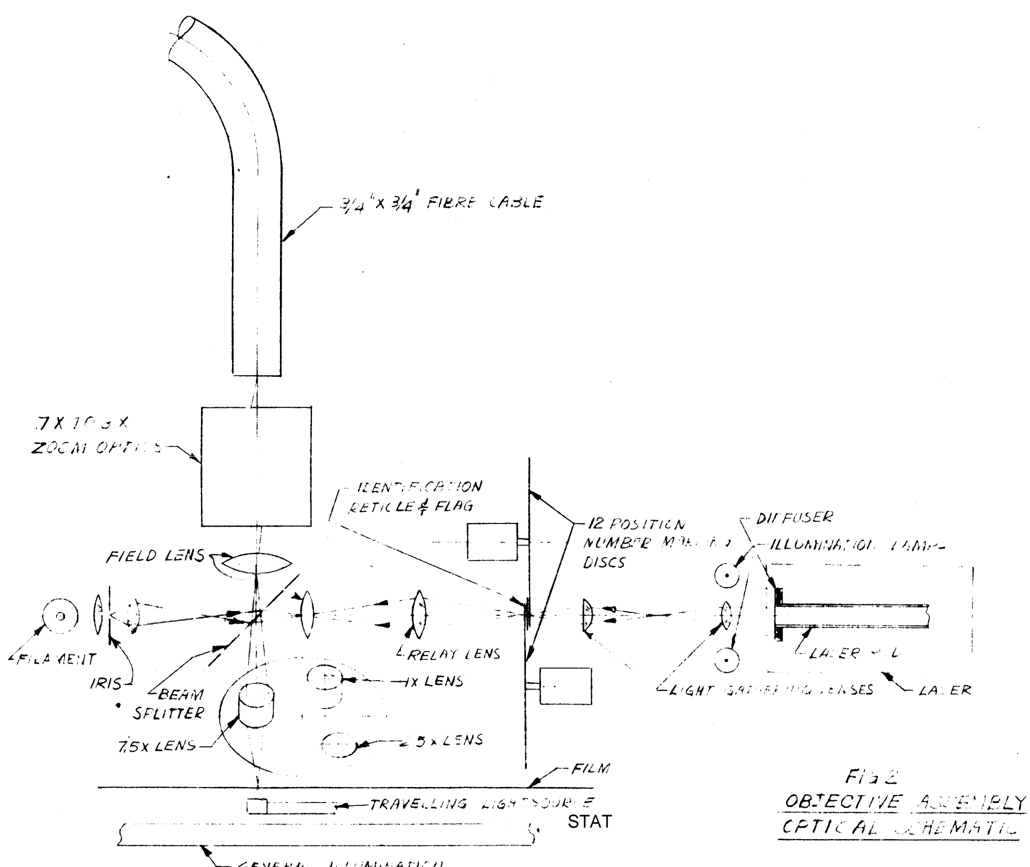

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FIG 2
OBJECTIVE ASSEMBLY
OPTICAL SCHEMATIC

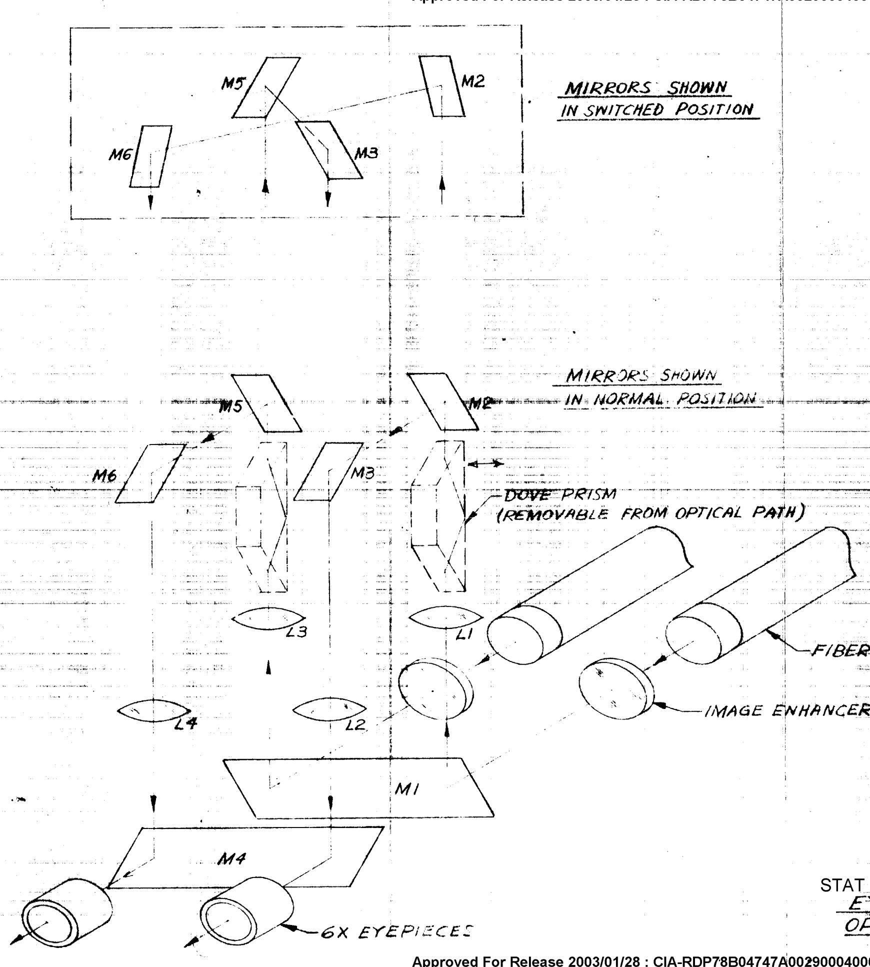

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FIG.3
EYEPIECE ASSEMBLY
OPTICAL SCHEMATIC

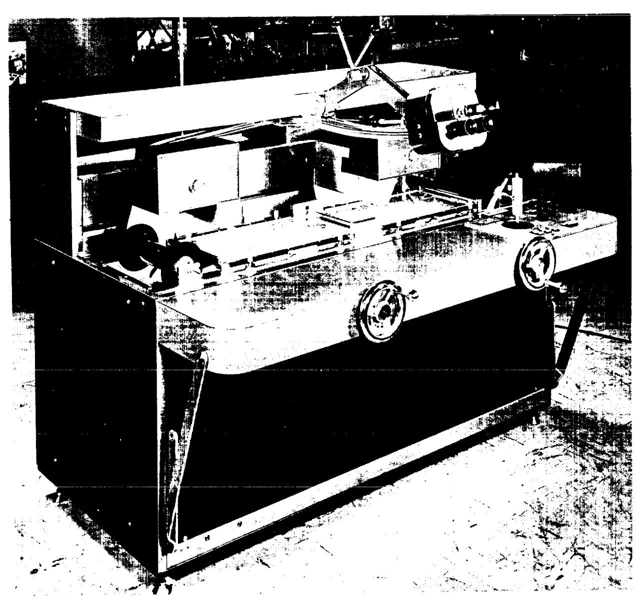

Figure 4.

Overall View High Magnification Viewer.

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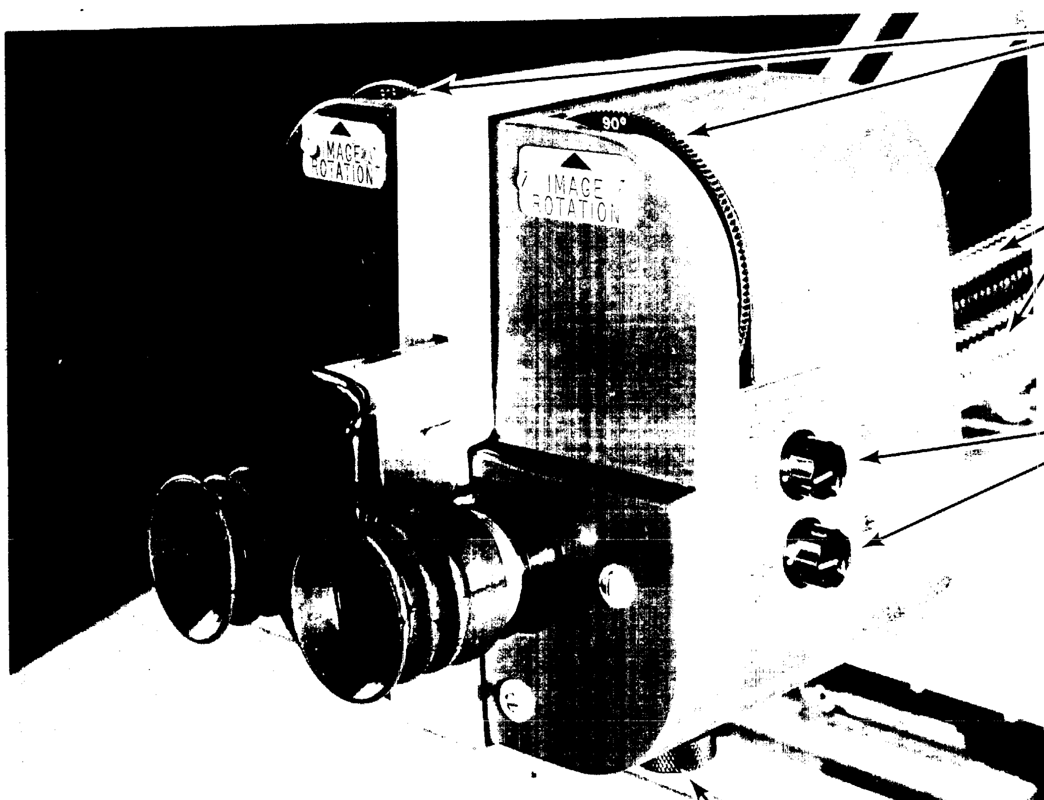

Figure 6.

Eyepiece Assembly for High Magnification Viewer.

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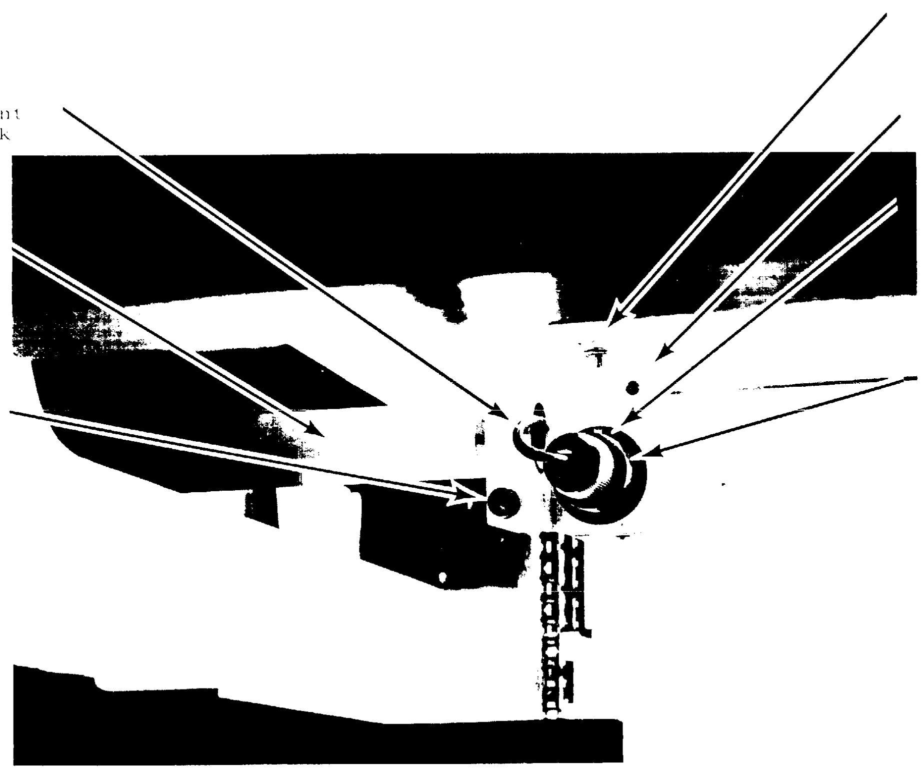

Figure 7.

Left Channel High Intensity Light Source as Seen Through Access Opening on Cabinet's Left Side.

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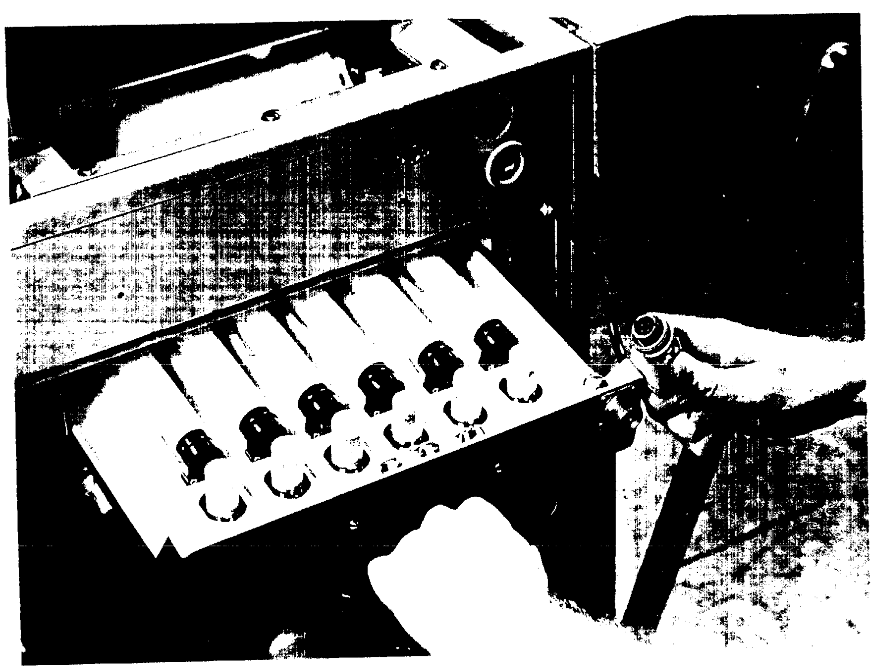

Figure 8.

Fluorescent Lamp Assembly (Left Channel Shown) Partially Removed From Cabinet Showing Extraction Means and Connector.

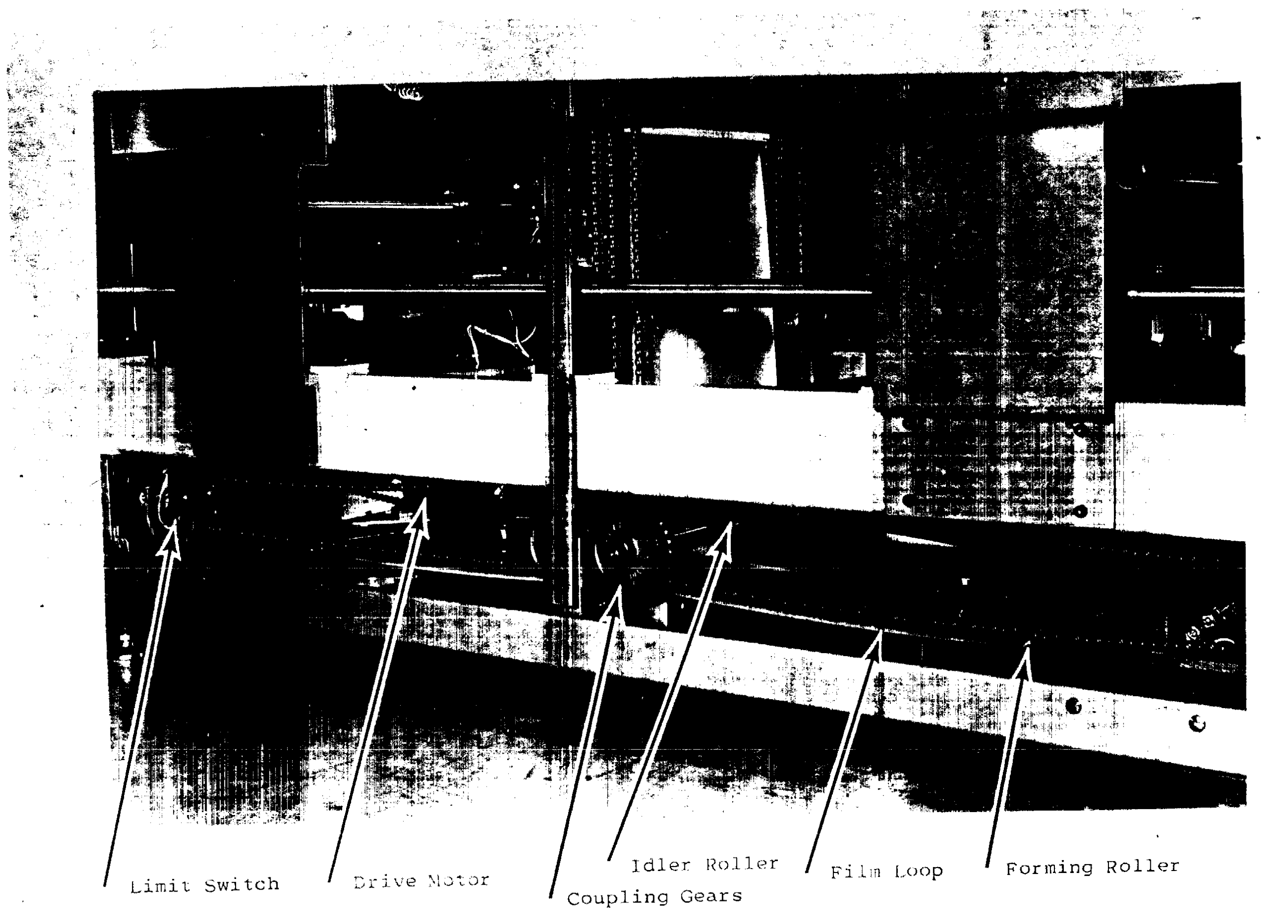

Figure 9.

Front View of Loop Forming Mechanism Containing Film and Shown with Approximately 7 Feet of Film in Loop.

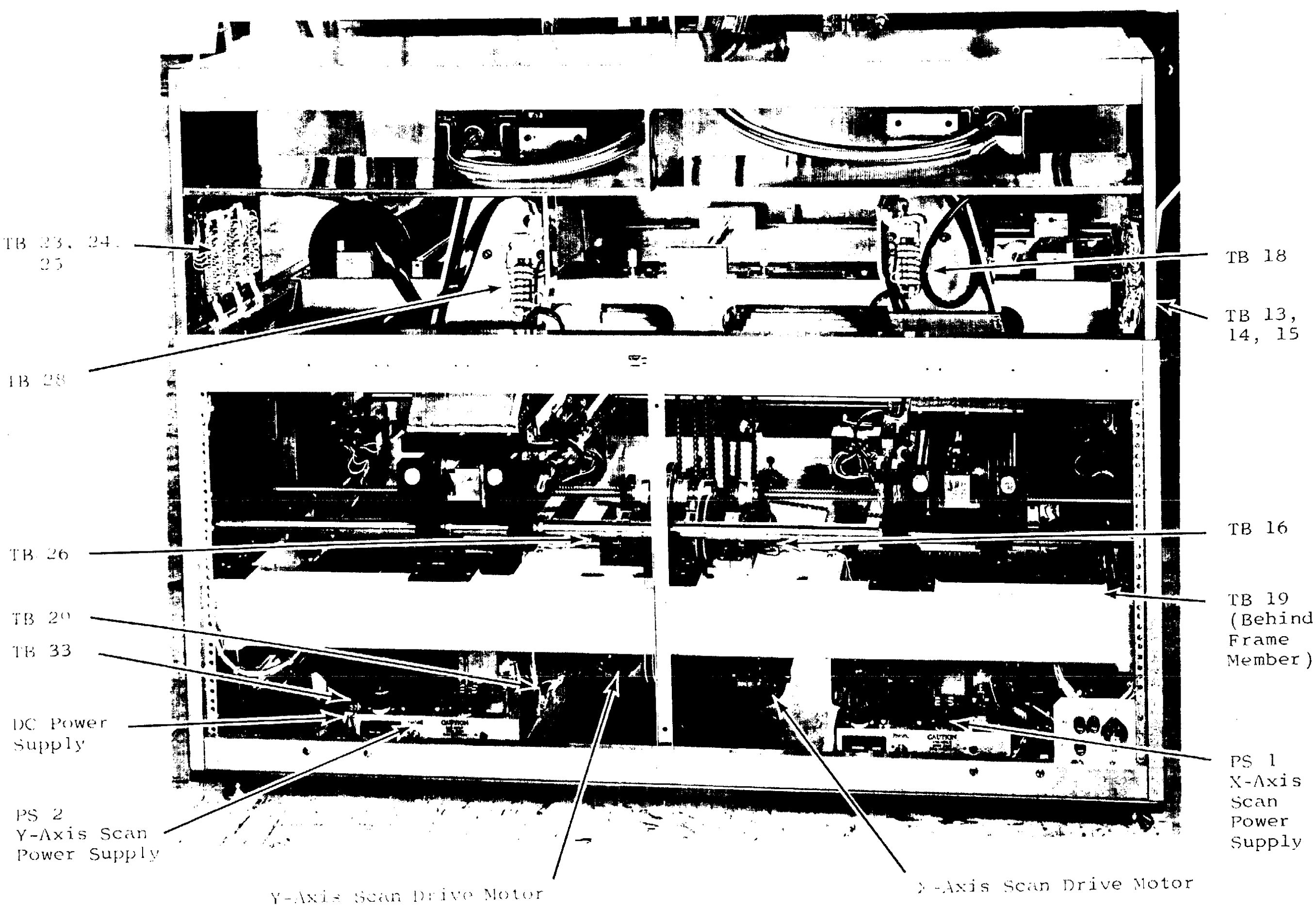

Figure 10.
Rear View of High Magnification Viewer with Covers Removed Showing Scanning Mechanism and Electrical Component Placement.

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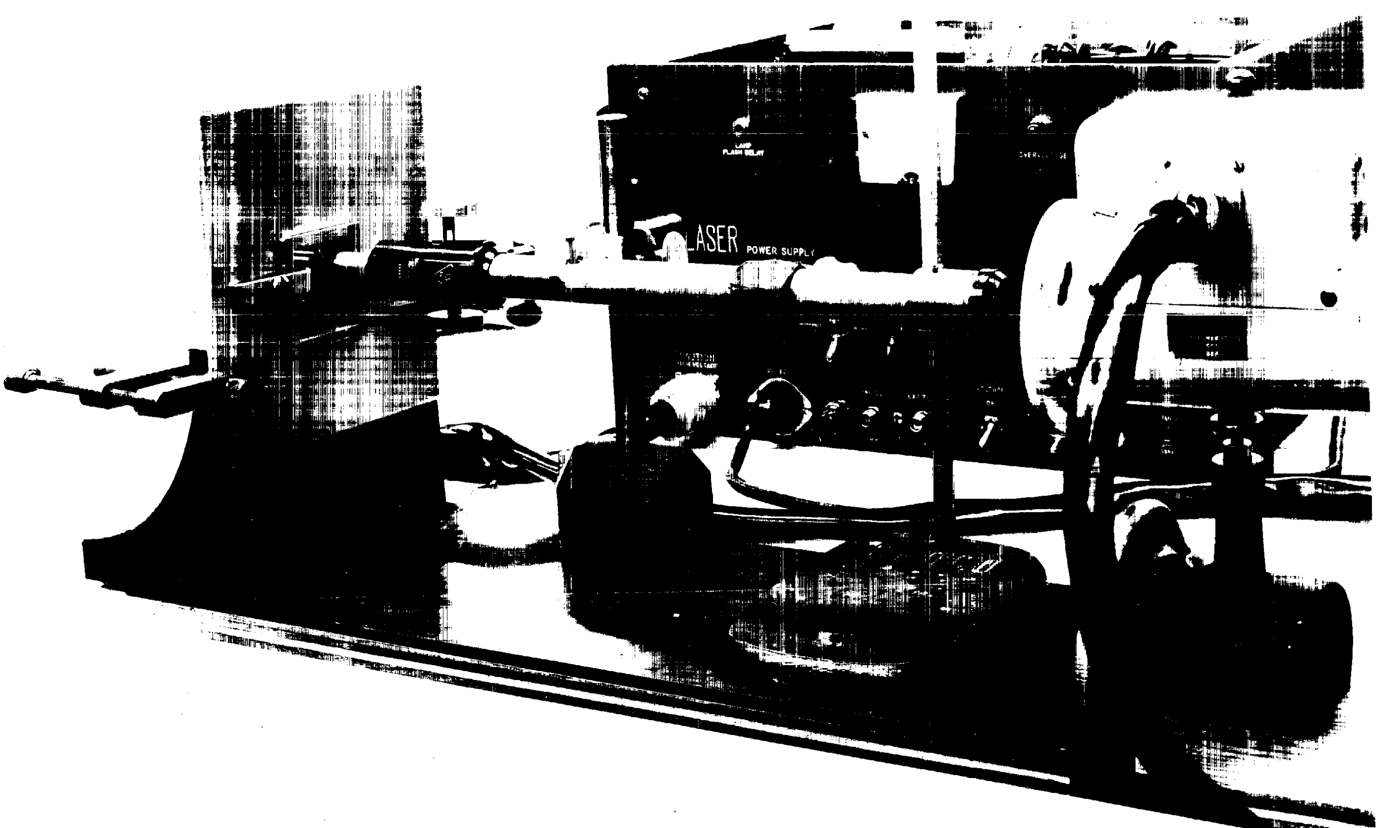

Figure 2.

Laser Film Identification Breadboard

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OPTIONAL FEATURE #2

DUAL JOY STICK COMPENSATION FOR MAGNIFICATION AND ORIENTATION

This optional feature utilizes the same stereoscopic transfer and viewing system, except for the type of carriage drives and the joy stick arrangement. A comparison is listed below:-

Proposed Approach #1 Described Previously:

The system contains one joy stick which controls either right or left carriages simultaneously or separately. The stereo scan is achieved by mechanically connecting through clutches the X and Y drives of the left format to those of the right format so that both carriages move in unison. Each optical channel or image can be rotated for angular orientation and varied in magnification separately; also, the joy stick can be rotated so that the apparent image and carriage motions are in correspondence for individual channel operation. The joy stick drives allow continuously variable speeds through D.C. motors. Only one joy stick is provided that can be manually rotated by the operator through a tangent screw.

Optional Feature #2:

In certain applications it may be desirable to simultaneously scan a stereo pair where the scale of one frame is not the same as the other. Consequently, it is desirable to stereo scan one frame at a different rate than the other. Thus, if the scale of Frame A requires a magnification twice that of Frame B in order to achieve the same image size to the eye, then the object size of Frame A is half that of B. Therefore, the speed of scan in A must be half that of B to assure correspondence in the stereo scan mode.

In addition to the above, another possibility exists where the Frame A is photographed at slightly different angular orientation to B. Consequently, the carriage drives for A must scan in a different direction from that of B.

Additional Feature #2 provides for simultaneous scanning of Frame A and Frame B with compensation to allow for: (1) different orientation; (2) different magnifications.

This is achieved by replacing the variable D.C. drives with step motors, which are driven by pulse generators, see Figures 1 and 2. The speeds of the drives are proportional to the repetition rate of the pulses which are in turn controlled by two joy stick mechanisms. A single stick is mechanically connected to each of the two X-Y motion control joy stick mechanisms. One joy stick mechanism controls the right scan, and the other mechanism controls the left scan; left, right or stereo mode being preset through a selector switch. To insure image and carriage motion correspondence the right and left joy stick mechanisms are mounted on rotatable mounts that can be independently oriented to ±180° in order to independently match any cable angular displacement. Thus, the right mechanism is manually rotated to follow up the right channel optical orientation determined by the rotation of the right fiber optical cable.

The left control mechanism is rotated to correspond to the left cable orientation. Easily observable indicator dials are located at the cable and joy stick, so that quick correspondence can be made. A separate price quotation (Feature 2A) includes an automatic servo followup so that the joy stick automatically follows the orientation of the cable.

To permit stereo scanning for differing magnifications, the X and Y carriage scanning speeds are automatically adjusted to compensate for non-matching magnifications in the left and right channels. To accomplish this, potentiometers are linked to the zoom optics which provide a speed increase or decrease of the right scan drive to correspond to its magnification; also, the left scan speed will be adjusted to correspond to the left channel magnification. In this manner, proper stereo scanning can be maintained independent of orientation and magnification differences of stereo pairs.

A selector switch allows for bypassing the magnification feedback; in addition, it is also possible to select a synchronized mode where the left carriage moves exactly in the same speed and direction as that of the right. This is simply achieved by having the same pulse generator control the right and left frames. No accumulation of errors can develop, independent of the number of starts and stops, due to the positive action of the stepping motor.

This feature enhances the overall system operation by providing faster photo interpretation while assuring maximum ease of operation with minimum operator fatigue.

[redacted]

DESCRIPTION

Figure 1 illustrates the pulse generation for speed control, while Figure 2 illustrates the general block diagram of the drives.

Figure 1 shows only the X axis control, the Y-axis being the same as the X-axis. An X_1-axis potentiometer control is provided at the right joy stick mechanism. The voltage developed at the center arm of the potentiometer is proportional to the angular displacement of the joy stick, and its servo angular orientation. This output is then applied to a potentiometer which is geared to the zoom control drive. Consequently, the output from the zoom potentiometer is inversely proportional to the zoom magnification. This voltage is applied to a pulse generator such that the repetition rate of the pulse generator is proportional to this input voltage. Each pulse represents a single step of the stepping motor. The repetition rate determines the speed of the carriage.

The pulse generator, controller and step motors are standard motors and electronic transistorized packages available from [redacted] STAT

The switch S1 can bypass the zoom potentiometer so that the output speed can only be dependent on the joy stick angular displacement. This switch is located on the control panel. In addition, selector switch S2 is provided to achieve any of the following controls:

1. Left carriage is actuated by the left joy stick, while the right carriage is completely de-energized.

2. Left carriage is controlled by the left joy stick while the right carriage is controlled by the right joy stick mechanism. The right joy stick mechanisms are linked to the left joy stick mechanically so that only one stick controls both mechanisms. This allows the right mechanisms' servo angular orientation to be independent of the left. Thus, the actual motion of the left carriage may be different in magnitude and orientation. However, the resultant displacement as apparent to the eye, would be identical for the right and left channel, as long as the scale and orientation of both frames does not change within the same viewed area.

3. Both left and right carriages are controlled identically by the left joy stick. This mode of operation is possible when left and right frames are the same in scale and orientation. Consequently, perfect synchronisms can be achieved since the same pulse generator is used for both left and right frames.

4. Right carriage is controlled by the right joy stick mechanisms; the left carriage and joy stick mechanism are de-energized.

[redacted]

Figure 2 illustrates the block diagram of the drive mechanisms. As shown, the right and left joy stick mechanisms are servo driven and rotated to correspond to the angular orientation of the fiber optics cables; this servo feature is priced separately as Feature 2A or manually (2). In this manner, up motion of the joy stick corresponds to up motion of the image independent of the orientation of the fiber cable. The accuracy of the servo is better than 2° in each axis. The motors are A.C. 60 cps servo motors driven by a standard transistorized amplifier. The joy stick mechanisms are identical to those used by [redacted] in Model 387 Viewer and in X-Y tables developed for the [redacted] STAT STAT [redacted] The linkage interconnecting the mechanisms is a pantograph type motion to assure correspondence in the X and Y axes of the two joy sticks, maintaining an independent orientation by a ball type pivot at the joy stick mechanisms.

Each step motor drives in one of two speeds: Fine - to achieve .0001" to .030" sec. through a gear train N1. The coarse drive is achieved by energizing a duplex clutch to allow the same motor to drive through gear train N2. In this manner a total variable speed of .010" to 1.0"/sec. is achieved. A selector switch at the joy stick allows selection of coarse and fine speeds. In addition, a jog switch is available at the top of the joy stick to allow step motion by approximately 1 micron per step. An alternate to the jog switch is a rotatable switch located at the handle of the joy stick to allow selection of fast, medium, and very slow speeds. The slowest speed is approximately 3 microns per second. The operator merely rotates the handle clockwise or counter-clockwise to achieve the selection of one of 3 speed ranges.

[redacted]

OPTIONAL FEATURE #3

FILM MOTORIZED DRIVE

The addition of motorized film drive is separately described here. This drive system is the same as that designed and developed by [redacted] for the X-Y Motion Viewer for the [redacted] Several of these have been manufactured. The cognizant government agency is invited to observe the operation of this system to determine whether a manual or motorized film drive is preferred. Each one of 4 spools is provided with a separate geared motor driving through an electro-magnetic slip clutch. The motors used are [redacted] M42 with an electronic continuously variable speed controller made by [redacted] Two controllers are provided to allow the operator to select any of the following modes:

1. Single film: Forward, reverse.

2. Two films are on the right (A), and one on the left (B). Drive either: A only forward or reverse; B only forward or reverse; A and B forward and reverse.

A multi-pole selector switch located at the control panel allows the selection of any of the modes listed above. Automatic removal of vacuum is provided as soon as the film drive switch is actuated. Continuously variable speeds of 40:1 ratio are controlled through a separate switch located at the control panel. The film movement cannot be started (unless the vacuum is removed) through an interlock switch. Vacuum removal is achieved through solenoid actuated valves. One valve actuates the right format, while the other actuates the left format. Consequently, the vacuum on the right or left format can be independently or simultaneously controlled.

OPTIONAL FEATURE #4

MOTORIZED LENS TURRET REMOTE FOCUSING

Separate focusing of each objective lens is provided within its focusing threaded mount, as a part of the main viewer. Optional Feature #4 allows the addition of a remote controlled motorized drive that allows the objective turret to be moved up and down for remote focusing from the control panel. It includes at the right and left scanning heads the following:

1. A geared D.C. motor which can be reversed and actuated by a rocker switch at the control panel.

2. Precision ways allowing smooth motion of the turret up and down without backlash or vibration.

3. Precise positioning is achieved by a self-locking precision worm drive, actuating the turret mounting block by the motor drive.

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[redacted]

OPTIONAL FEATURE #5

RIGIDIZED CASTING SUPPORT FOR FUTURE MEASUREMENT CAPABILITY

This optional feature replaces the lower weldment supporting the X and Y carriages with rigidized stabilized castings. The X and Y axes rods are supported from below continuously by precision ground supports continuously across their length in order to assure maximum stability with extensive usage and time.

Space will be provided for future utilization of Moire Fringe gratings made by [redacted] for automatic visual readout or storage into punched tape or card.

The change of design of the 387 system is not extensive due to this feature. It essentially changes the configuration of the lower support of the carriages and rod supports.

OPTIONAL FEATURE #6

AUTOMATIC ZOOM CORRESPONDENCE TO PROJECTED DOT

This feature includes the addition of a cam linkage between the projected reticle and the zoom optics in order to automatically change the zoom without effecting the subtended angle of the dot to the eye. The proposed system utilizes an iris diaphragm that is continuously variable in diameter from .010" to approximately 0.2". This cam will be provided to allow automatic change of the iris by linking it to the zoom knob. In this manner, if the zoom magnification is increased by a factor of 2, the iris diaphragm diameter is decreased by a factor of 2, maintaining the appearance of the reticle constant. In addition to the above, the manual change of reticle size from 1' to 4' at the eye is maintained.

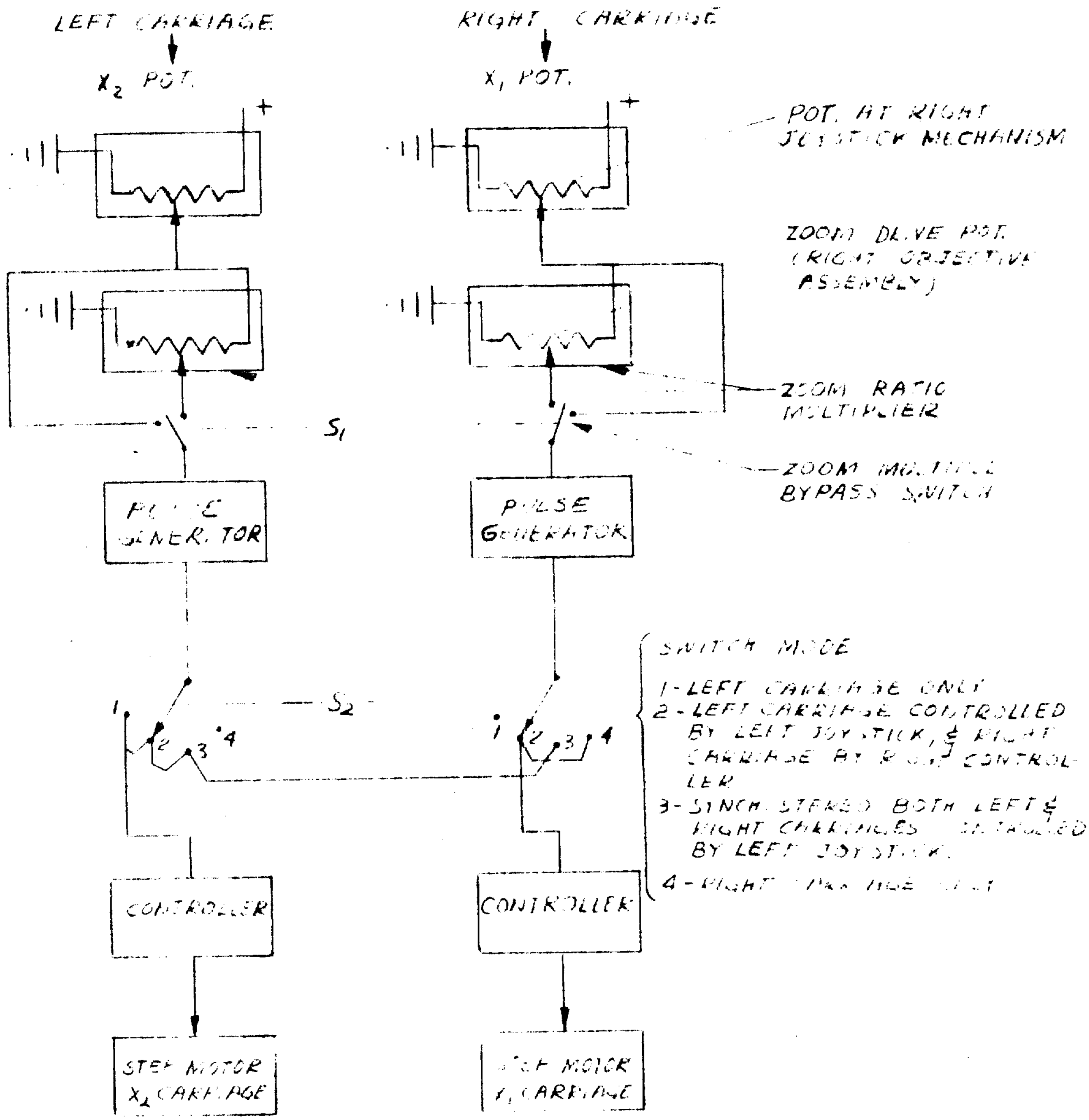

FIG 1

X AXIS CONTROL

(Y AXIS SAME AS ABOVE)

OPTIONAL FEATURE #2

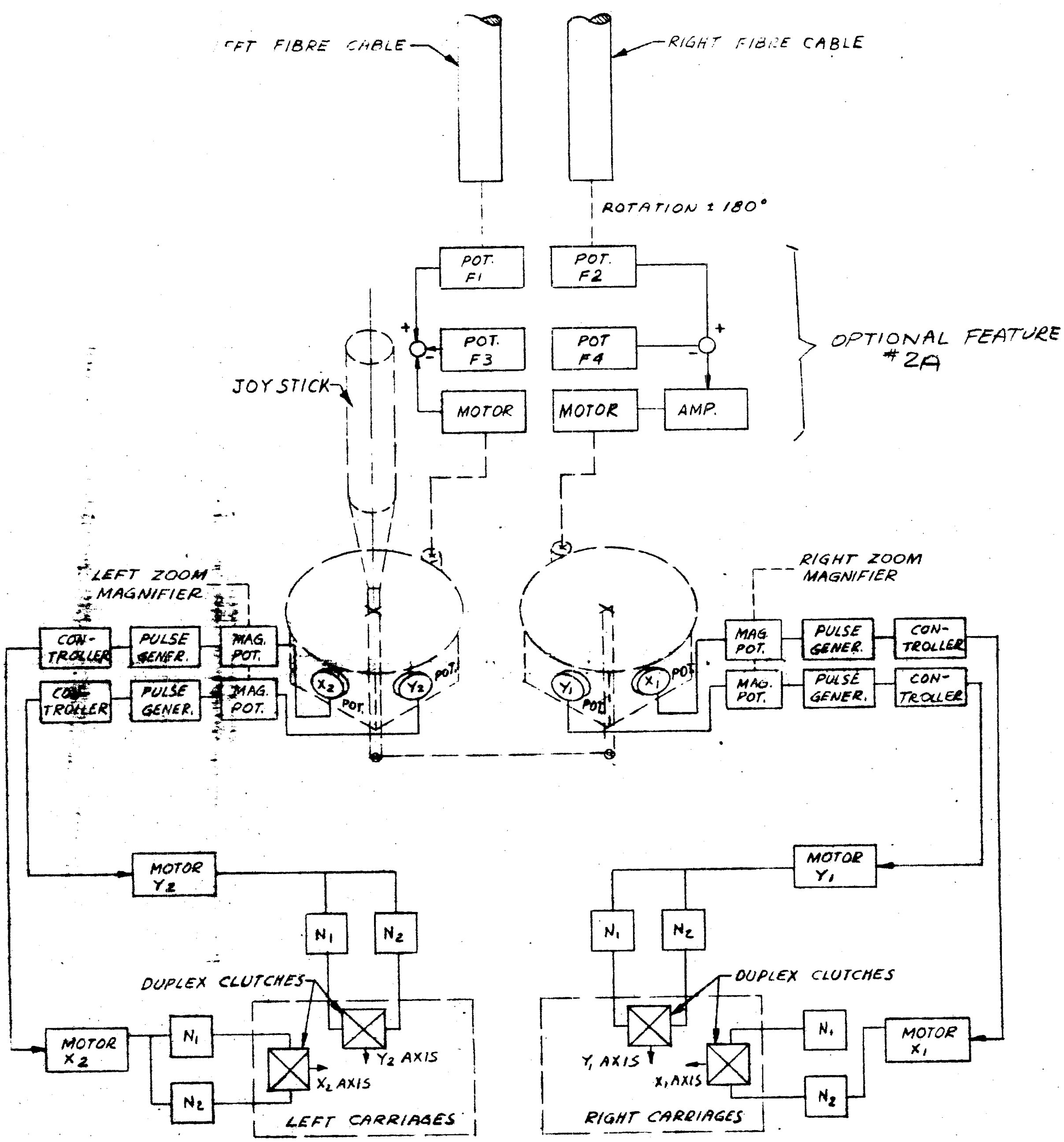

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FIG. 2
BLOCK DIAGRAM
OPTIONAL FEATURE #2A & 2B.

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